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(52) Domestic classification G1B CA
(56) Documents cited GB 1401225 GB 1372004 GB 1240303 GB 1198488
(58) Field of search G1B
(71) Applicant Biospecia Limited, 47 Ealing Road,

(54) Apparatus for chemical analyses

(57) An apparatus for the chemical analyses of substances, e.g. for use in blood grouping comprises:

a loading station (10) for receiving a series of carrier racks (18) each for a plurality of test tubes (19) each of which tubes contains a sample of the substance to be analysed; a first dispensing unit (11) for dispensing a required amount of reagent liquid into each of the test tubes in the carriers; a second dispensing unit (14) for dispensing a metered amount of chemical agent into each of the test tubes; a reading unit (16) comprising a photometric system to pass beams of light through the test tubes, and light-sensitive means (62) for sensing the light transmitted through the test tubes; an unloading station (17) for discharging the test tube-containing carriers; and, a print-out unit (68) to deliver printed analyses of the analytical results derived from the reading unit.

ERRATUM

SPECIFICATION NO 2095829A

Front page, Heading (72) Inventor *below* Sharma *insert* Ian Sidney Gould

THE PATENT OFFICE
10 November 1982

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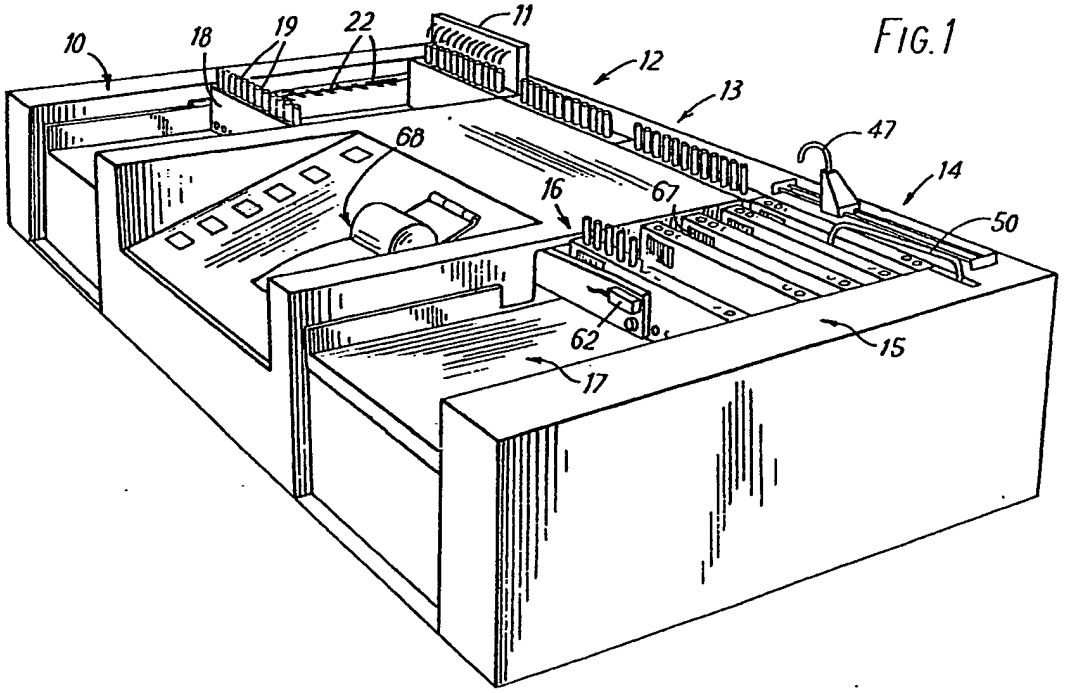

FIG. 1

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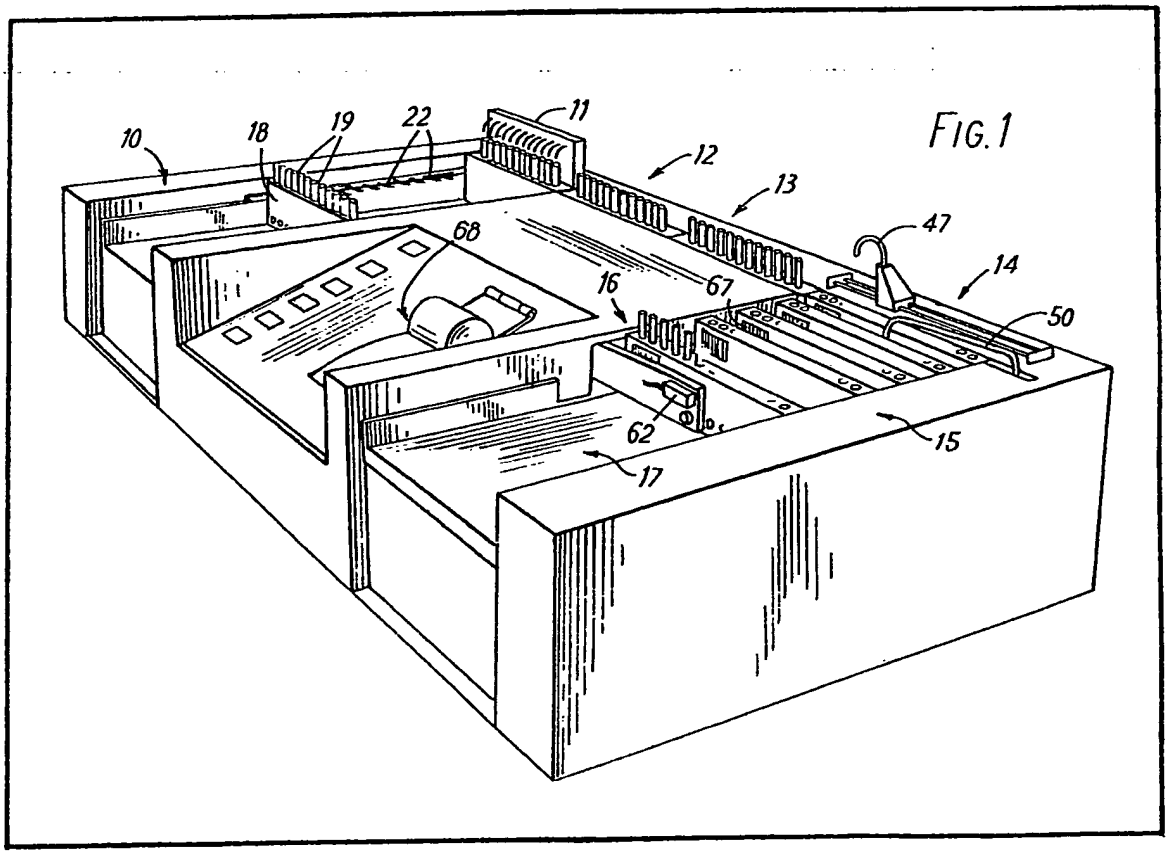

FIG. 1

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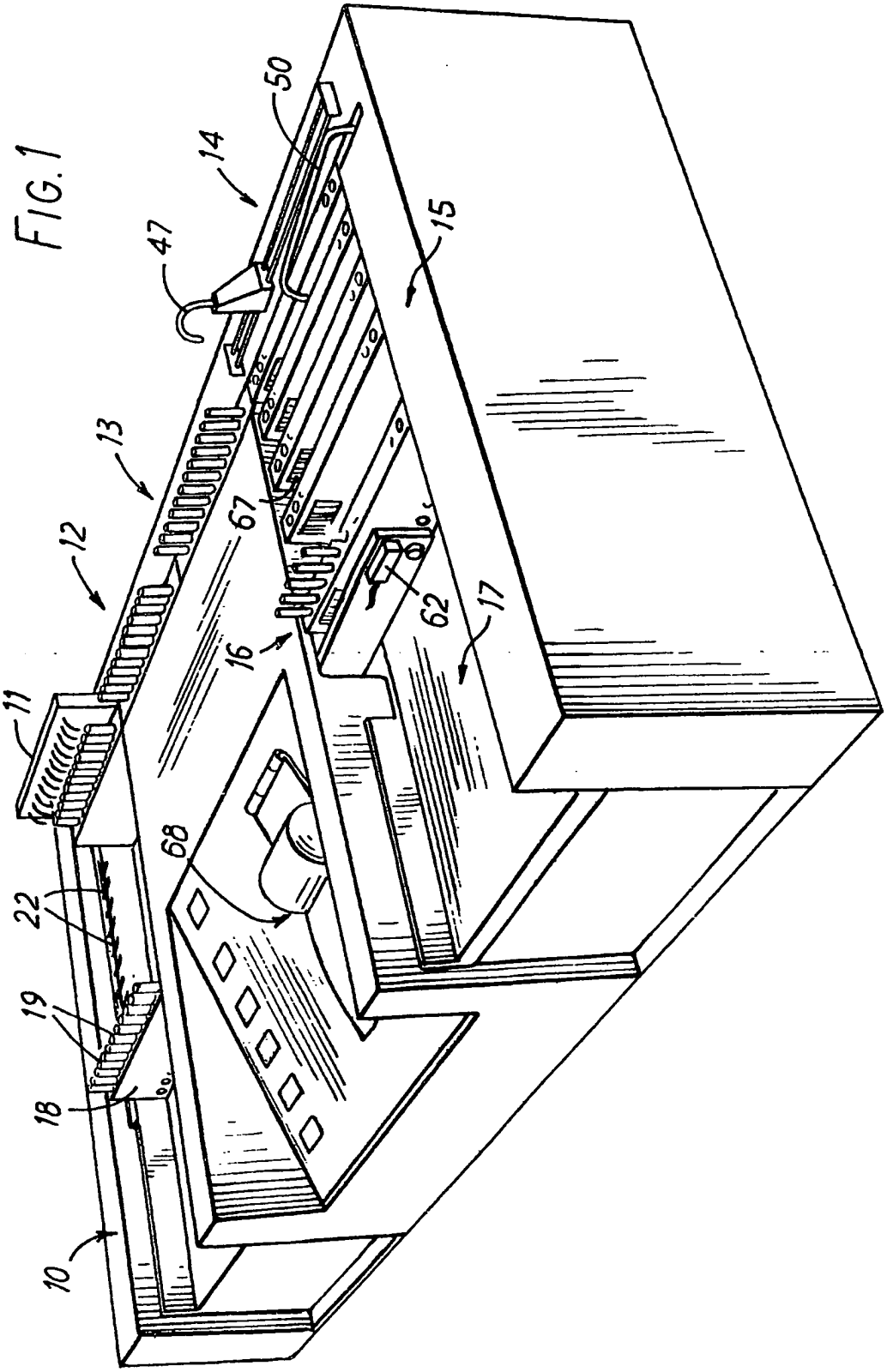
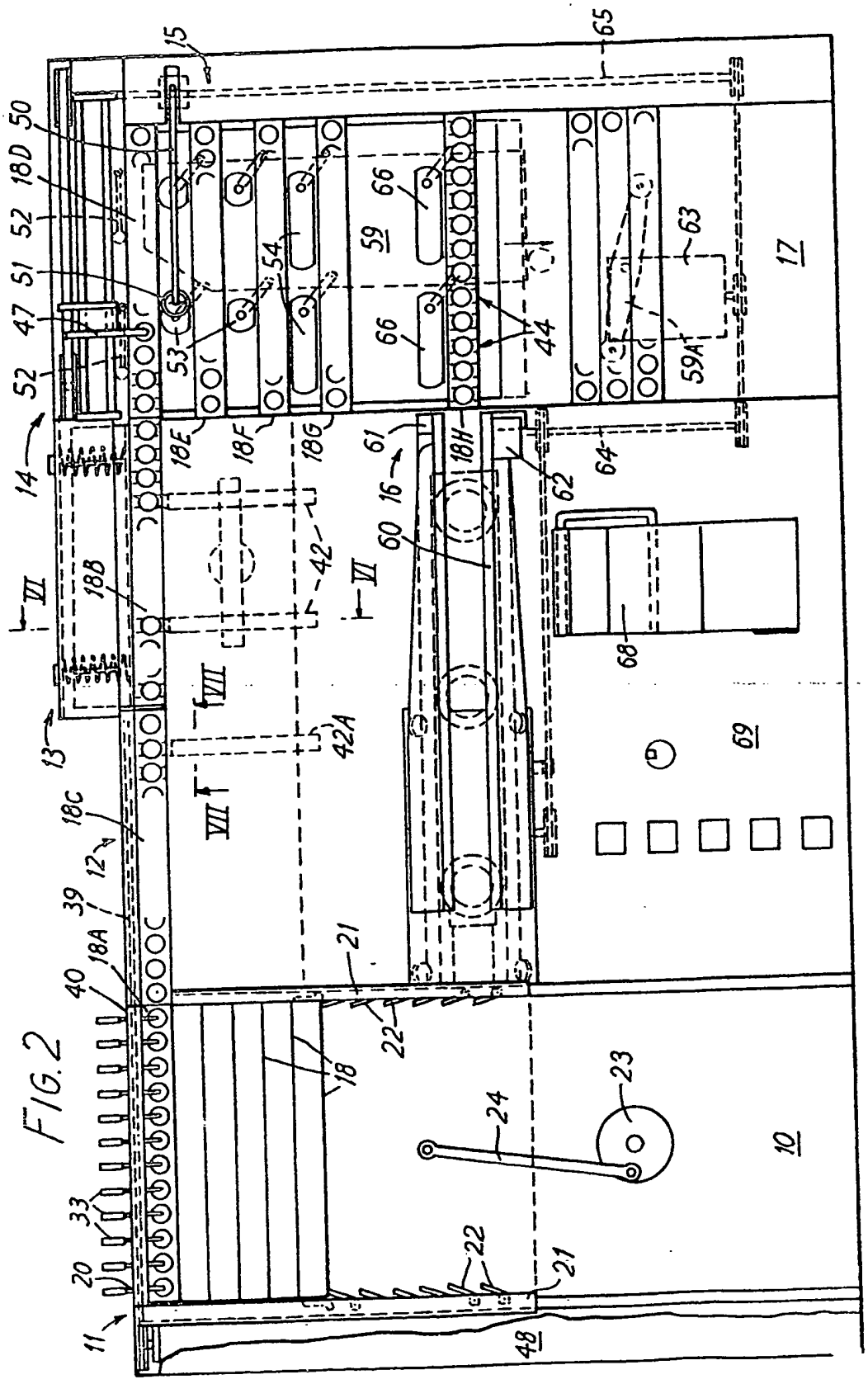
FIG. 1





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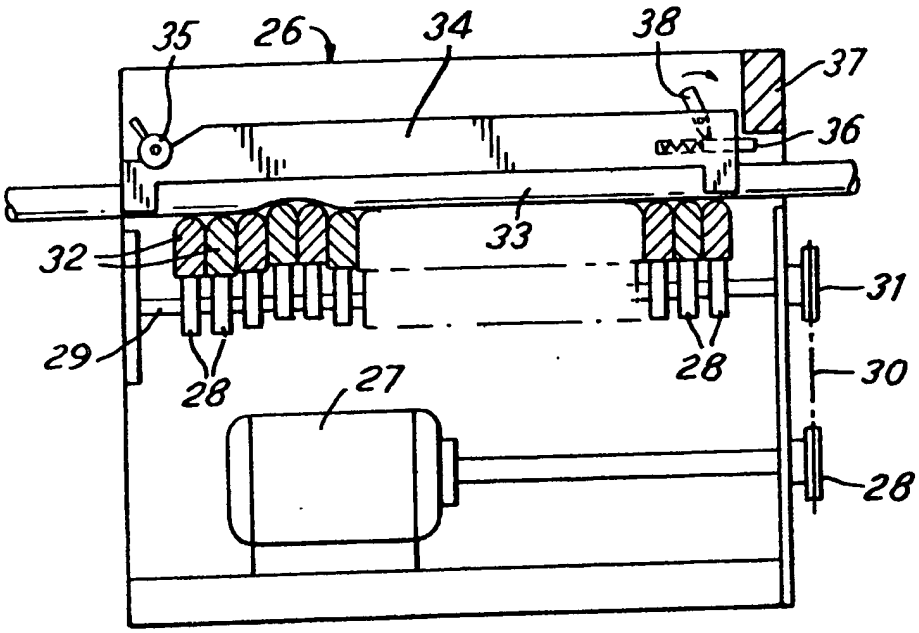
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FIG.4

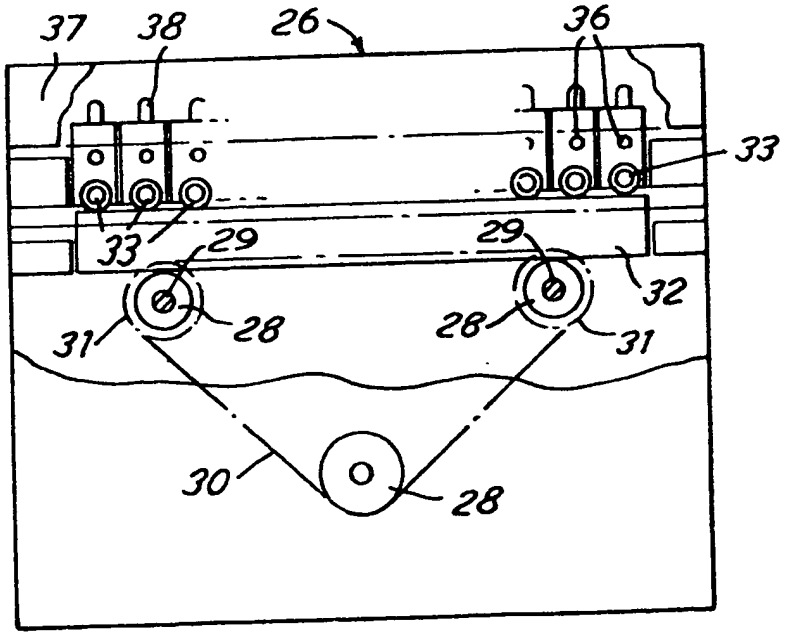
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FIG.5

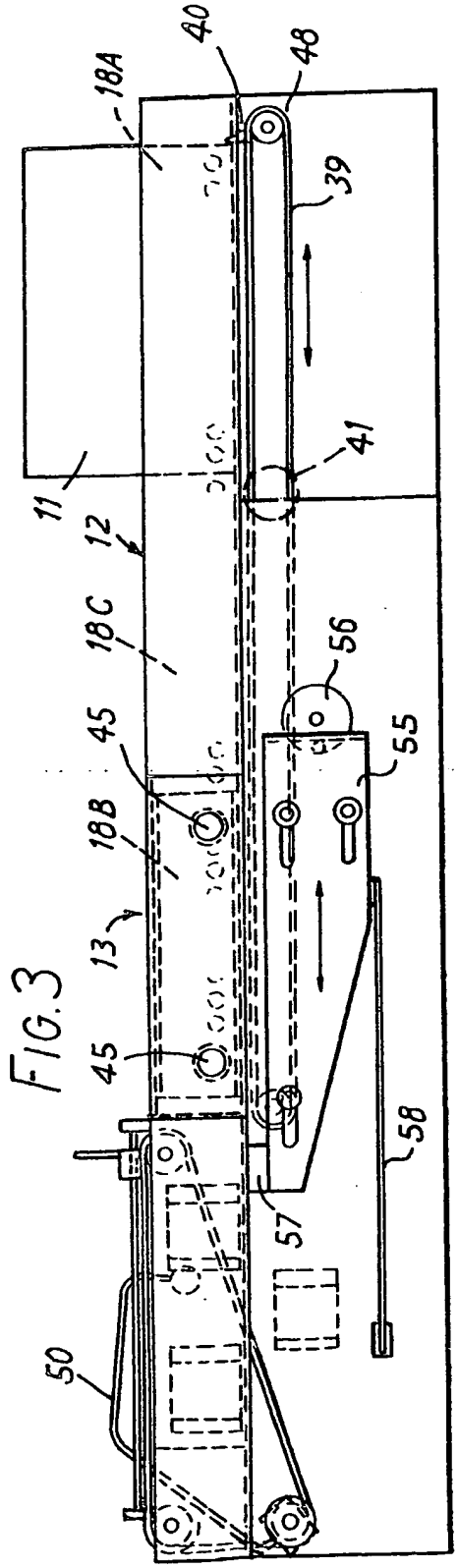

FIG.3

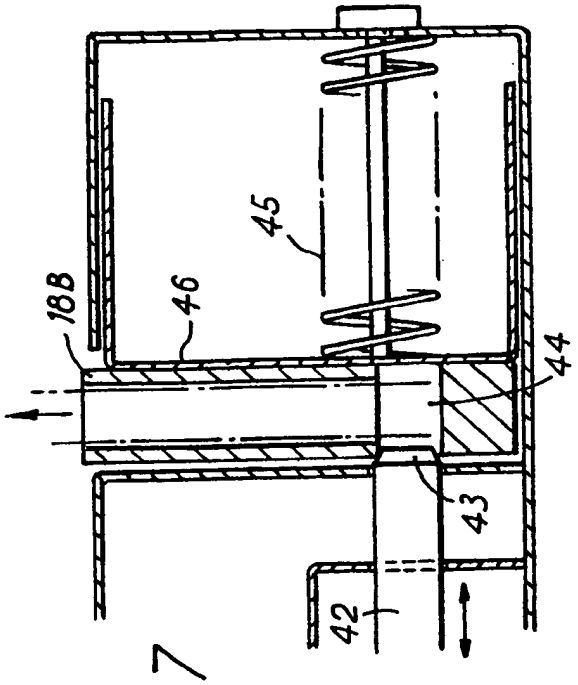

FIG.7

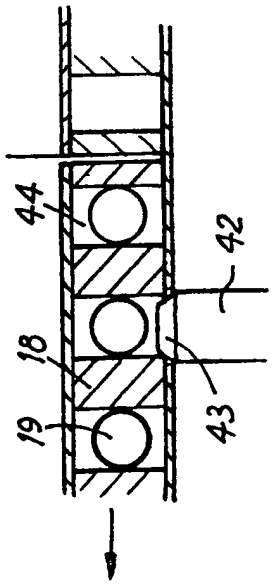

FIG.6

SPECIFICATION

Apparatus for chemical analys s, particularly for use in blood grouping

This invention related to apparatus for chemical analyses and particularly, but not exclusively, for use in blood grouping.

Various forms of apparatus for blood grouping have previously been proposed such as in U.S. Patents Nos. 3,334,018, 3,624,223, 3,432,268, 4,104,031 and 4,130,395. However, various disadvantages are involved in all these prior machines, and it is an object of the present invention to provide an improved apparatus in which these disadvantages are at least reduced.

The essential features of one embodiment of apparatus according to the present invention include:

a) A loading station for receiving a carrier for a plurality of test tubes or like receptacles, each tube containing a sample of the liquid suspension;

b) a first dispensing unit for dispensing the required amount of reagent liquid into each of the test tubes in the carrier;

c) a second dispensing unit for dispensing a metered amount of biochemical agent possibly as defined below into each of the test tubes;

d) a reading unit comprising a photometric system to pass beams of light through the test tubes, and light-sensitive means for sensing the light transmitted through the test tubes;

e) an unloading station for discharging the test tube-containing carriers; and

f) transport means for transporting the carriers from the loading station through the dispensing units, and the reading unit, to the loading station.

The aforementioned biochemical agent may comprise from 0.1 to 1.0 g/l of a nonionic surface-active agent which is a water soluble protein-compatible anionic detergent, in an aqueous isotonic buffered solution which has a pH value of from about 6.5 to 8.0 and exhibits an osmolarity of from 300 to 400 milliosmol/kg, a sodium content of about from 125 to 225 milliequivalents/l, and a potassium content of from about 3.5 to 7.5 milliequivalents/l. Preferably, the nonionic surface/active agent is a polyoxyethylene either of C_{12}—C_{16} alkyl alcohol containing from about 20 to 25 oxyethylene units.

However, the various features of the apparatus have applications other than to blood grouping or even immunological analyses; embodiments and features of the present invention will now be described, by way of example, with reference to the accompanying drawings in which:—

Figure 1 is a p rspective view showing an apparatus for use in immunological analysis, and specifically applicable to blood grouping;

Figure 2 is a plan view corresponding to Figur 1;

Figure 3 is a r ar view f th apparatus shown in Figures 1 and 2;

Figures 4 and 5 ar diagrammatic side and rear elevations sh wing a pump unit for anti-sera;

Figur 6 is an enlarged s ction on the line VI—VI f Figure 2; and,

Figure 7 is a detail on the line VII—VII of Figure 2.

Referring to Figures 1 and 2 of the drawings, the apparatus consists essentially of a loading station 10, a first dispenser unit 11 for anti-sera, a delay station 12, an agitator unit 13, a second dispensing unit 14 for the biochemical agent, a stepwise progression unit 15, a reading unit 16, and an unloading station 17.

In use of the apparatus, carrier racks 18 containing up to twelve test tubes 19 are fed manually to the loading station 10, and the racks are drawn to a position below spouts 20 of the dispenser unit 11 by means of a reciprocating console 21 which carries side rows of spring-loaded driving pawls 22. The consol is reciprocated by means of an electric motor (not shown) driving a rotary disc 23 and con-rod 24 which is pivotally connected to the underside of the consol.

At the dispensing unit 11, identical quantities of different anti-sera are introduced simultaneously through the spouts 20 into (in this case, seven of the twelve) test tubes of rack 18A by means of a novel peristolic pump unit which is shown in Figures 4 and 5. The pump unit 26 has an electric motor 27 driving a first pinion 28 which rotates a pair of cam shafts 29 through a chain 30 and a pair of pinions 31. The shafts 29 carry pairs of aligned cam surfaces which cause shaped transverse rods 32 to oscillate vertically in a wave-like manner. Twelve flexible tubes 33 are individually carried by shaped supports 34 to be sandwiched between the rods and the supports which are stationary; the supports are engaged at their one ends under adjustable cam-like discs 35 and have spring loaded tongues 36 at their other ends which engage under a frame member 37 but are retractable by individual levers 38. With this arrangement pumping of liquid along the tubes 33 is effected as the rods rise and fall under the action of the rotating cam shafts 29.

After a period of 1-1/4 minutes, the rack is moved to the delay station 12 by means of a reciprocating chain drive 39 which carries at least one pusher finger 40 and which is driven by a reversing electric motor 41. The rack remains in the delay station for a period of 1-1/4 minutes, and is then progressed by a following rack or by a pusher finger 40 to the agitator unit 13.

The agitator unit includes three spigots 42 having tapered ends 43, as can be seen from the detail Figures 6 and 7, and the right-hand spigots enter op nings 44 in th rack 18B to raise the rack slightly and th n vibrate or oscillate th rack transversely of its l ngth, this movement being assisted by return springs 45 which engage a shaped m tal pusher plat 46. The raising of the rack 18B prevents rubbing f its base on th b dy of the machine. To prevent friction with the rack 18C in the delay station 12, th left-hand spigot 42A enters the opening 44 in th rack 18C to

move the two racks a short distance apart. The left-hand spigot does not reciprocate.

After agitation for a period of 30 seconds, and then a delay of 45 seconds, the rack (18B) is moved to the second dispensing unit 14 where a movable spout 47 dispenses identical quantities of the biochemical agent, fed by a pump at 48, into each of the first seven tubes, in timed sequence. A tube-counting sensor 49 is provided to prevent dispensing of a possibly corrosive fluid into an absent tube at unit 14. In this position (18D) the rack is held against forward tilting by means of a pivotal arm 50 which carries a low-friction plastics ball 51 at its distal end. After the dispensing stage 14, the rack 18D is moved towards the reading unit 16 by means of coupled pivotal levers 52 to adjacent delay position 18E and then by pushers 53 to further and relatively close delay positions 18F and 18G, before being carried by swivel fingers 54 the relatively greater distance into precise alignment with the reading unit 16.

Referring to Figure 3, a rear plate 55 is reciprocated by an electric motor 56 to operate the pushers and lever arms through a first connecting member indicated at 57 and, through a second connecting rod 58, to reciprocate a horizontal plate 59 (Figure 2) which coacts with a lever 59A. The plate 59 rises and falls to move the pushers and the lever arms into and out of the path of the racks in the progression unit 15.

At the reading unit, a two-arm reciprocating roller-guided carriage 60 carries a solid-state laser-type beam emitter 61 to direct beams of light successively through each pair of openings 44 in the rack and thus through the lower parts of the test tubes 19 which contain the liquid solution. A PIN photo-diode sensor 62 simultaneously moves behind the rack to take photometric readings from the beam flashes which are of very short duration. The sensor is also employed to compensate for varying ambient light levels. A preferred light source is a high-intensity LED emitting at 565 mμ (green) which is acceptably close to the 545 mμ which is preferred for scanning blood sample agglutinations, without employing filters at the emitter or sensor. The LED is of attractively small size, eliminating the need for a projection lens system, and has the further advantages of giving a narrow spread of light, using low power, emitting little heat, and requiring low maintenance. Also, the capacity for high-speed on/off operation allows ambient light to be sensed without the use of a chopper wheel as is required in a tungsten-lamp system.

An alternative light-emitter system is a conventional lamp with a chopper and filter sited in a convenient part of the apparatus and having a fibre-optic connection to the emitter head. As shown in Figure 2, electric motor 63 drives a shaft 64 to reciprocate the carriage 60, and also a shaft 65 to swing the pivotal arm 50 and move the spout 47.

After the reading stage (18H), the rack is moved to the unloading station by means of further lever arms 66 and the racks then collect at the unloading station 17 for suitable removal.

As a further feature of the invention, the racks 18 carry bar-code identifications, suitably on adhesive labels 67 (Figure 1) which are also sensed at the reading unit 16. The results of the photometric tests are then fed into a suitable microprocessor and the analyses are delivered in printed form, together with the identification of the blood sample, at print-out unit 68 on control panel 69.

Modifications may be made without departing from the scope of the invention and, as indicated above, the inventive concepts of, for example, the peristolic pump unit, the LED emitter and sensor or the fibre-optic system, the reciprocating pawl drive arrangement, and the agitator unit, may have useful applications in apparatus other than for blood grouping or even chemical analysis.

Claims (filed 29.3.82)

1. An apparatus for use in the chemical analyses of substances, comprising:

a loading station for receiving a carrier for a plurality of test tubes or like receptacles, each tube containing a sample of the substance to be analysed;

a dispensing unit for dispensing a required amount of reagent into each of the test tubes in the carrier;

a reading unit comprising a photometric system to pass beams of light through the test tubes, and light-sensitive means for sensing the light transmitted through the test tubes;

an unloading station for discharging the test tube-containing carriers; and,

transport means for transporting the carriers from the loading station through the dispensing unit, and the reading unit, to the loading station.

2. An apparatus for use in the chemical analyses of liquid suspensions, comprising:

a loading station for receiving a carrier for a plurality of test tubes or like receptacles, each tube containing a sample of liquid suspension;

a first dispensing unit for dispensing a required amount to reagent liquid into each of the test tubes in the carrier;

a second dispensing unit for dispensing a metered amount of chemical agent into each of the test tubes;

a reading unit comprising a photometric system to pass beams of light through the test tubes, and light sensitive means for sensing the light transmitted through the test tubes;

an unloading station for discharging the test tube-containing carriers; and,

transport means for transporting the carriers from the loading station through the dispensing units and the reading unit, to the loading station.

3. An apparatus as claimed in claim 1 or Claim 2, in which said carrier comprises a horizontal rack for carrying a row of test tubes in upright positions.

4. An apparatus as claimed in any preceding

claim, in which said transport means include drive means to transport said carrier and subsequent similar carriers from said loading station to said (first) dispensing unit, said drive means comprising a consol arranged to reciproate in a generally horizontal plane and carrying side rows of spring-loaded pawls to engage the ends of the carrier.

5. An apparatus as claimed in any preceding Claim, in which said (first) dispensing unit comprises a peristolic pump in which a row of flexible feed tubes are acted upon by a series of transverse rods which reciprocate in succession against the tubes to pump similar quantities of liquid along the feed tubes to dispensing spouts.

6. An apparatus as claimed in Claim 5, in which said rods are reciprocated under the action of spaced parallel cam shafts, the cams of which rotate to provide a wave-like effect.

7. An apparatus as claimed in any preceding Claim, in which an agitator unit for agitating said test tubes is provided between said (first) dispensing unit and said reading unit.

8. An apparatus as claimed in Claim 7, in which said agitator unit comprises horizontal spigot members which engage a test-tube carrier in the agitator unit, raise the carrier slightly from a base support, reciprocate the carrier transversely, and lower the carrier back onto the base support.

9. An apparatus as claimed in Claim 8, in which, in said agitator unit, the carrier is sandwiched between said spigot members and a spring-loaded vertical plate.

10. An apparatus as claimed in any of Claims 6 to 8, in which a delay station is provided between said (first) dispensing unit and said agitator unit, and a stabilising spigot member is arranged to engage and isolate from a reciprocating test-tube carrier in said agitator unit, a test-tube carrier in the delay station.

11. An apparatus as claimed in any preceding Claim, in which a test-tube counting sensor is provided at said first and/or said second dispensing unit.

12. An apparatus as claimed in any preceding Claim, in which said transport means includes a drive arrangement for transporting said carrier and subsequent carriers from said (second) dispensing unit to said reading unit, the drive arrangement comprising pivotal levers and pushers which move the carriers from the (second) dispensing unit to adjacent delay positions, and swivel fingers which move the carriers from the delay positions a relatively greater distance to the reading unit, the levers and pushers being mounted on a reciprocating plate which rises and falls to move the levers and pushers into and out of the path of the carriers.

13. An apparatus as claimed in any preceding Claim, in which said reading unit has a reciprocating carriage carrying firstly a laser beam emitter to direct beams successively through openings in the carrier and thus through lower parts of the test tubes, and secondly a sensor to receive and take photometric readings from the beams which have passed through the test tubes.

14. An apparatus according to any preceding Claim, and further comprising a micro-processor arranged to receive signals from said reading unit, analyse the signals, and print out the results of the analysis.

15. An apparatus as claimed in Claim 14, in which each carrier is provided with a bar-code the identification from which is fed to said micro-processor.

16. An apparatus for use in chemical analysis, substantially as hereinbefore described, with reference to the accompanying drawings.

17. A method of chemical analysis, substantially as hereinbefore described with reference to the accompanying drawings.

18. The features herein described, or their equivalents, in any novel selection.

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(b) An information disclosure statement shall be considered by the Office if filed by the applicant within any one of the following time periods:

(1) Within three months of the filing date of a national application other than a continued prosecution application under § 1.53(d);

(2) Within three months of the date of entry of the national stage as set forth in § 1.491 in an international application;

(3) Before the mailing of a first Office action on the merits; or

(4) Before the mailing of a first Office action after the filing of a request for continued examination under § 1.114.

(c) An information disclosure statement shall be considered by the Office if filed after the period specified in paragraph (b) of this section, provided that the information disclosure statement is filed before the mailing date of any of a final action under § 1.113, a notice of allowance under § 1.311, or an action that otherwise closes prosecution in the application, and it is accompanied by one of:

(1) The statement specified in paragraph (e) of this section; or

(2) The fee set forth in § 1.17(p).

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(e) A statement under this section must state either:

(1) That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement; or

(2) That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge

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